

CHARLES RIVER WATERSHED STUDY

PLAN of SURVEY

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 ENGLAND DIVISION, CORPS OF ENGINEERS
 WALTHAM, MASSACHUSETTS

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PLAN OF SURVEY
FOR
COMPREHENSIVE WATER AND RELATED
LAND RESOURCES INVESTIGATION
CHARLES RIVER WATERSHED
MASSACHUSETTS

1. INTRODUCTION

This plan of survey sets out the general procedures being followed in developing a comprehensive plan for water and related land resources for the Charles River Watershed.* Orientation, direction, and coordination are indicated as well as the inter-relationships and missions among the participants in the study.

2. AUTHORITY FOR STUDY

RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, UNITED STATES, ADOPTED 24 JUNE 1965.

"That the Board of Engineers for Rivers and Harbors is hereby requested to review the report on Land and Water Resources of the New England-New York Region printed in Senate Document Numbered 14, 85th Congress, First Session, with particular reference to the Charles River Basin and tributaries, Massachusetts, with a view to determining the advisability of improvements in the interest of flood control, water supply, recreation, water quality control, navigation, tidal flood control, allied purposes and related land resources. "

*An impoundment formed by the Charles River dam located near the mouth of the river is known locally as the Charles River Basin. To avoid confusion, the entire area draining to the Charles River will be referred to throughout the remainder of this study as the "Charles River Watershed. "

3. STUDY OBJECTIVE

The basic objective of the Charles River Watershed study is the formulation of a plan of development which will serve as a guide for the best use, or combination of uses, of water and related land resources in the watershed to meet foreseeable short and long-term needs. To this end, consideration will be given to meeting present and future requirements for water supply, flood control, navigation, water quality control, recreation, fish and wildlife, and other purposes requiring development of water and related land resources. The investigations will emphasize formulation of a detailed plan to meet these needs through 1980 and indicate potentials to meet the needs through 2020. The plan will include components to supplement existing and currently planned developments so as to meet the 1980 needs of the basin. Measures capable of meeting longer term requirements will be incorporated in the plan.

4. WATERSHED DESCRIPTION

The Charles River watershed is located in eastern Massachusetts bordering on the watersheds of the Mystic, Merrimack, Blackstone, Taunton and Neponset Rivers and includes all or portions of 5 cities and 30 towns. The Watershed is about 307 square miles, including an important and highly developed portion of Metropolitan Boston and less developed but rapidly growing suburban and rural areas.

The 35 cities and towns wholly or partially in the watershed study area, and the percentage geographically of each municipality within the watershed, are as follows (CITY names in CAPITALS, towns lower case):

1. Arlington ✓	less than 0.1%	19. Mendon	less than 0.1%
2. Ashland ✓	less than 0.1%	20. Milford	86.4
3. Bellingham ✓	42.1	21. Millis ✓	100
4. Belmont ✓	40.2	22. Natick ✓	55.2
5. BOSTON	57.2	23. Needham ✓	100
6. Brookline ✓	100	24. NEWTON ✓	100
7. CAMBRIDGE	62.2	25. Norfolk ✓	99.8
8. Dedham ✓	66.9	26. Sherborn ✓	83.5
9. Dover	85.6	27. SOMERVILLE ✓	34.0
10. Foxboro ✓	less than 0.1%	28. Walpole ✓	9.8
11. Franklin ✓	90.7	29. WALTHAM	100
12. Holliston ✓	99.7	30. Watertown	86.3
13. Hopedale	18.8	31. Wayland ✓	less than 0.1%
14. Hopkinton ✓	10.2	32. Wellesley ✓	100
15. Lexington ✓	29.5	33. Weston ✓	91.0
16. Lincoln	61.3	34. Westwood ✓	34.0
17. Medfield	78.2	35. Wrentham ✓	43.3
18. Medway ✓	100		

The basin is hour-glass in shape with a length in a southwest-northeast direction of 31 miles and widths of 15, 6 and 15 miles in a northwest-southeast direction. Elevations vary from 586 feet, mean sea level, along the southwesterly rim of the basin in Hopkinton to below 10 feet, msl, along the lower $8\frac{1}{2}$ miles of the Charles River.

The estimated 1965 watershed population is 856,000. About 75% of this total is in the cities of Boston, Cambridge, Somerville, Newton and Waltham and the Towns of Brookline and Watertown, all located in the lower portion of the watershed. In the ten-year period 1955-1965, there may have been a small decline in total population within these six communities whereas the other communities in the watershed have generally experienced rapid growth and development.

Precipitation of both rain and snow averages 44.4 inches of water per year within a range of 43 to 47 inches. Runoff in the upper 80 percent of the watershed averages 22 inches. The runoff from the lower 20 percent which is highly urbanized is considerably higher. It is estimated that 89 percent of the flood peaks in the Charles River Basin originate within the lower watershed area, below Moody Street, Waltham.

5. CURRENT STATUS OF WATER AND RELATED LAND RESOURCES IN THE BASIN

a. Navigation. Until about 1910, the $8\frac{1}{2}$ mile reach of the Charles River from the mouth at Boston Harbor to a dam at Watertown was tidal with a range of tide of 9.5 feet. The completion of the Charles River Dam in 1910 with navigation lock and sluice gates converted this reach to a fresh water basin with a design level 2.4 feet above msl. For many years the lock has been adequate for decreasing commercial navigation and the increasing recreational boating. Doubt now exists of the ability of the lock to handle present and anticipated future boat traffic efficiently.

Navigation in the river above Watertown Dam is restricted to shallow draft pleasure boats such as canoes, kayaks, and shallow draft out-board motor boats. The Watertown Dam, rebuilt by MDC in 1967, and the many upstream dams, lack facilities to lift boats from level to level. Natural channels are narrow and shoal and there are numerous obstacles, such as rocks and trees.

b. Flood Control. Increased urban development in the Watershed has created flood problems. The situation is particularly acute in the Charles River Basin area between the Charles River Dam and the Watertown Dam.

Urbanization has increased the rapidity and volume of runoff, and encroachment by highway and other improvements since 1910 has reduced the storage capacity of the impoundment by eliminating the extensive swamps which first bordered the original impoundment.

The existing Charles River Dam completed in 1910 separating the river from the tidal water of Boston Harbor has provisions for gravity sluicing of the river flow. The tide level is above Basin level for one-third of the time during normal tides and for one-half of the time during storm tides. Gravity discharge is impossible at those times. The Basin water surface elevation is then determined by the storm inflow.

The Metropolitan District Commission has altered the spillways of the Moody Street and Silk Mill dams and improved a section of channel upstream of the Silk Mill Dam in the interest of flood control. The Commission has also constructed an adjustable control gate at Mother Brook and improved a section of Mother Brook Channel which empties into the Neponset River. The Commission is authorized to dredge and otherwise improve the Charles River and its tributaries between and including the Watertown Dam and the South Natick Dam so as to relieve flood conditions, and to construct, re-construct and repair such dams and gates as may be required for such purposes.

The Waterways Division, Massachusetts Department of Public Works, has completed a short section of channel improvement and a conduit enclosing the Charles River in the Town of Milford.

c. Pollution. Municipal and industrial wastes in various stages of treatment are emptied into the Charles throughout much of its length. Pollution has been particularly severe in the lower 40 miles where overloaded MDC intercepting sewers formerly relieved raw sewage into the river. MDC improvements costing over \$110,000,000 when placed in operation will help eliminate much of this pollution. During periods of heavy rainfall, combined sewers in the older municipalities will continue to discharge to the river and tributary streams.

During periods of extreme low flow in the river, the MDC, under Chapter 603 of 1950, has provided as much as 15 million gallons of water per day from its reservoir at Lake Cochituate to increase flow and partially dilute pollution in the Charles River, up to a maximum of 500,000,000 gallons per year, but only when MDC deems such water available.

d. Water Supply. The principal source of water for the Boston Metropolitan District is from outside the Charles River Watershed. The Metropolitan District Commission supplies water to 11 of the cities and towns in the Watershed with about 60 percent of the population of the watershed. The principal source of supply is the Quabbin Reservoir, located some 50 miles west of the watershed.

The City of Cambridge and the Towns of Lincoln, Wellesley and Weston obtain water from surface sources within the lower watershed. The Cambridge, Wellesley and Weston supplies, and others, are supplemented by MDC. Dedham and Wellesley are supplied from dug, gravel packed and tubular wells fed from the Charles River. Needham receives about 50% of its supply from MDC, the remainder from wells within the town. Many of the remaining towns derive their domestic water supplies from local ground water sources.

e. Recreation. The original concepts of the Charles River Basin Commission at the turn of the century included the maximum utilization of the Basin and shoreline for park and recreation purposes. As a consequence, most of the basin shoreline and significant portions of river banks along the lower 10 miles of the river are now in Metropolitan District ownership. Development and use of this property has generally followed recreational demand.

The possibilities of recreational development along the Charles and in areas related to the Charles and its tributaries throughout the Watershed are very large. Action is much needed because of great recent suburban growth in the area. There are opportunities for all forms of active and passive recreation. The principal obstacles include poor water quality, low flows, dumping and urban development of potential recreation sites. Public acquisition, improvement, maintenance and proper planning of recreation areas has not kept pace with population shifts and growth.

6. DESIRES OF LOCAL INTERESTS

Determination of the desires of local interests and indication of means for resolving of conflicts will be an important part of the investigation. The numerous state and local governmental agencies and local groups in the watershed have expressed desires which in part include:

a. Review of the flood problem in the Basin and in the Muddy River and other critical areas.

b. Review of the solution for the Basin flood and navigation problem proposed by the Metropolitan District Commission. A report prepared for the Commission recommends a new dam downstream of the existing 1910 Charles River Dam with more adequate locks and sluice gates and a pumping station. Consideration of this and of other proposals involves still other proposed developments such as the Inner Belt Highway and Massachusetts Bay Transportation Authority Construction.

c. Consideration of means to prevent encroachment on the flood plains and other areas adjacent to the Charles River and its tributaries upstream of the Watertown dam. Continued filling of natural storage areas and high intensity land utilization without adequate provision for open areas could lead to economic and aesthetic losses in the near future.

d. Consideration of multiple purpose storage in the headwaters for recreation, flood control, low flow augmentation, fish and wildlife.

e. Conservation of open spaces throughout the watershed and increased recreational development. The desires and needs for industrial and commercial expansion, highway construction and housing development are not known at this time. These important factors and their effects on runoff, water demands, and pollution will be given careful consideration in the study.

Public hearings were held on January 17th, 19th and 24th, 1967. These provided all interests three opportunities to express their desires.

7. COORDINATION

The Division Engineer, New England Division, Corps of Engineers, has been assigned the major responsibility for the accomplishment of the study. Assistance and guidance is afforded by the Coordinating Committee comprised of representatives of each of the participating Federal agencies and of State agencies designated by the Governor of Massachusetts. The Division Engineer, as Chairman, will direct the Committee's periodic review of the progress of the study. Committee functions include the following:

- a. Offer guidance.
- b. Apprise the heads of Federal agencies and of State and local agencies of the progress and the trends of the studies.
- c. Resolve differences or indicate available means for resolving differences, possibly outside the Committee.
- d. Assist in coordinating efforts of participants, and
- e. Aid in presenting to the public the results of the coordinated comprehensive planning effort.

Members of the Coordinating Committee are listed below:

Chairman - Division Engineer

New England Division, Corps of Engineers
Colonel Remi O. Renier, U. S. Army

Membership

Commonwealth of Massachusetts

Robert L. Yasi, Department of Natural Resources
Howard Whitmore, Metropolitan District Commission

Federal

Benjamin Isgur, Department of Agriculture
Edwin W. Webber, Department of Commerce
Mark Abelson, Department of the Interior
Albert V. Soukup, Department of Health, Education & Welfare
Frank A. Batstone, Department of Housing & Urban Development

In addition to the Coordinating Committee, a "Citizen Advisory Committee" was formed 1 May 1967 of residents of the watershed representing many and diverse interests. The Committee will provide valuable information on specific desires, problems and conflicts which exist in the watershed.

8. PARTICIPATION OF AGENCIES

Federal agencies will participate in varying degrees with the Corps of Engineers in the study. Several agencies of the State will assist in the investigations by providing available data from State studies, and advice to the participating Federal agencies. Contacts between the Federal and State agencies will be facilitated by the Coordinating Committee. The needs and desires of the state in the development of water resources are being ascertained through the Coordinating Committee which also is utilized to consolidate and reconcile participants' views.

A. DEPARTMENT OF THE ARMY

(1) The Corps of Engineers is to:

(a) Coordinate efforts and provide guidance and pertinent data for the investigations undertaken by cooperating agencies as necessary inputs to any specific overall study effort and arrange for and hold conferences and meetings as needed in connection with the study.

(b) Making full use of Federal and Federally-assisted prior reports, develop Charles River Watershed land use and population inventories, also projections to 1980 and 2020, and statements of land development alternatives, with appraisals of major metropolitan development forces influencing the Charles River Watershed.

(c) Collect Watershed economic data and develop economic projections bearing on present and future uses of water and related land resources.

(d) Determine the magnitude of present and future requirements for major flood control measures including local protection and drainage improvements. Evaluate flood problems and measures to lessen these problems in cooperation with the U.S. Department of Agriculture.

(e) Determine the magnitude of present and future requirements for commercial and recreational navigation facilities and determine measures to satisfy these requirements.

(f) Conduct hydrological studies of the Watershed necessary to determine streamflow characteristics, runoff-storage relationships, frequencies of adverse high flow and low-flow conditions, dependable yields from storage impoundments and optimum streamflow regulation. The use and operation of Mother Brook in diverting flows from the Charles to the Neponset River will be reviewed and studied. This will require consideration of Neponset River hydrology.

(g) Inventory, screen, and analyze sites for water resource development in cooperation with the U.S. Department of Agriculture and other agencies to fulfill the needs for water supply, water-oriented recreation, fish and wildlife conservation and improvement, streamflow augmentation, and other purposes. Surface water studies will be conducted by the Corps with aid and review by U.S. Departments of Agriculture, Interior, and Health, Education and Welfare. Ground water studies will be conducted by the U.S. Geological Survey.

(h) Correlate and consolidate information from studies by participating Federal and State agencies and from others, and provide leadership for the cooperative formulation of a comprehensive plan of development of the water resources of the Watershed. The Corps will draft the main report and coordinate it at field level with the participating Federal and State agencies.

B. U. S. DEPARTMENT OF AGRICULTURE

(1) The Soil Conservation Service (in cooperation with the Economic Research Service, the Forest Service and others) will study in preliminary investigation scope to:

(a) Determine the extent and management of agricultural, and forest lands above the South Natick Dam;

(b) Cooperate with the Corps of Engineers in developing projections of population growth and economic expansion in the entire watershed area which will affect land use changes in the watershed;

(c) Determine the location and extent of present and projected damages from floodwater, sediment, inadequate drainage, and erosion above the South Natick Dam. Appraise the measures needed to lessen these damages in cooperation with the Corps of Engineers.

(d) Inventory, screen, and analyze potential sites for surface water resource development on tributaries upstream of South Natick Dam. Cooperate with the Corps of Engineers in developing a program to fulfill needs for water supply, low flow augmentation, fish and wildlife development, flood-prevention, water oriented recreation, and other purposes.

(e) Appraise present and projected agricultural and rural community needs for water;

(f) Identify the existing woodland areas which might advantageously be maintained in woodland for preservation of open space, aesthetics, wildlife habitat, recreational and other purposes;

(g) Identify and appraise the practices needed to maintain and improve the woodland for these purposes;

(h) Assist in developing estimates of needs for outdoor recreational opportunities which might be satisfied in the watershed.

C. DEPARTMENT OF COMMERCE

(1) Economic Development Administration. Provide consulting service as to needs in the region and impacts of proposed improvements on redevelopment areas.

(2) Bureau of the Census. Furnish population and economic data as available on request, including an advance run of 1970 resident population data in 1969, if possible, also a statement of the principal differences in method of population counting each 10 years, 1860-1960.

(3) Weather Bureau. Furnish meteorological data and available studies as requested along with their views as to flood warning measures.

D. U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE

(1) The U.S. Public Health Service, through its Water Supply and Sea Resources Program, will carry out those activities assigned to it under the 1965 (Federal) Water Pollution Control Act, which will include the following:

- (a) All health aspects of water pollution;
- (b) Assistance to Federal, State and local agencies concerned with the development, treatment and distribution of public water supplies;
- (c) Provide guide-lines and assistance concerning water quality for domestic use and for body contact recreation;
- (d) Provide advisory consultation services in connection with vector control at water impoundments.
- (e) Review plans for the construction of sewage treatment plants, in cooperation with the Federal Water Pollution Control Administration, where the effluent from such plants will affect shellfish growing waters.
- (f) The Public Health Service role in the Charles River Study may also include reviewing reports prepared by other agencies, such as the water pollution control agencies, and submitting comments covering the health aspects of these reports. The amount of field work to be devoted to the Charles River Study by the Public Health Service will depend on the resources, professional staff, and funds available to the Public Health Service for this study.

E. U.S. DEPARTMENT OF HOUSING & URBAN DEVELOPMENT

(1) The Office of the Regional Director, Region One, New York City, is to:

(a) Furnish a list of regional bodies and of Charles River Watershed municipalities to which Federal grants for planning have ever been made at any time under Title VII, Sec. 701 of the U. S. Housing Act of 1954 as amended, and indicate the year of completion of work under each grant or indicate that work is in progress.

(b) Furnish a list of regional bodies and of Charles River Watershed municipalities to which Federal loans for advance engineering of public works have ever been made at any time, and a list of those to which a Federal grant to aid the construction of any such public works have ever been made at any time under Title VII, Sec. 702 of the U. S. Housing Act of 1954, as amended.

(c) Furnish a list of regional bodies and of Charles River Watershed municipalities that have applied for Federal aid for open space acquisition, for open space development, and for urban beautification aids under the H. U. D. programs.

(d) As required, advise the Corps Charles River Study Unit on the applicability within the Watershed of all the foregoing programs, and assist in working with participating agencies and municipalities in the Charles River Watershed to develop an open space action program.

F. U. S. DEPARTMENT OF THE INTERIOR

(1) The Federal Water Pollution Control Administration will perform the following tasks in the Charles River Watershed Comprehensive Study:

(a) Municipal and Industrial Water Supply Needs. Procure, compile, evaluate and analyse basic data concerning water usage and water sources in the Charles River Watershed. Develop projection equations for determination of estimates of future water requirements. Prepare estimates of Watershed water supply requirements for the years 1980 and 2020. The 1963 Inventory of Municipal Water Facilities will be up-dated by the FWPCA and will serve as a source of basic data. The Projective Economic Studies of New England, prepared 1964-1965 by Arthur D. Little, Inc., plus any other forecasts of the Watershed future economy that the Corps chooses to procure or furnish, will serve as an economic base for determination of future water needs.

(b) **Water Quality Control Needs:** Procure, compile, evaluate and analyse basic data concerning existing water quality, pollution control facilities and waste discharges in the Watershed. Develop and report in writing on stream flow augmentation requirements throughout the Watershed, utilizing mathematical models which incorporate projected waste loadings, based on economic indices.

Sources of pollution along the Charles River and tributaries will be geographically located by the FWPCA and will be identified by FWPCA as to nature of effluent and agency source, so far as possible.

The 1962 Inventory of Municipal Waste Facilities will be up-dated by the FWPCA and serve as a source of basic data.

The Projective Economic Studies of New England prepared 1964-1965 by Arthur D. Little Company, Inc., plus any other forecasts of the Watershed future economy that the Corps chooses to procure or furnish, will provide economic indices for determining future waste loading.

(c) **Evaluation of Benefits and Selection of Alternative Components of Basic Plans.** Prepare estimates of benefits to be realized from:

1. Providing storage for stream flow regulation and for water quality control.
2. Providing storage for municipal and industrial water supplies.
3. Participate, with the Corps and others, in selecting alternative Watershed water-resources components of a development plan.

(d) Prepare a report on municipal and industrial water supply needs and water quality control needs, for the entire Charles River Watershed, with projections of those needs for 1980 and 2020, and evaluations of benefits anticipated as stated above.

(2) Bureau of Outdoor Recreation is to:

(a) Furnish estimates of existing and future needs for water-related outdoor recreation in the Watershed.

(b) Evaluate the recreation potential of specific water control structures, both existing and proposed to determine their importance in any future recreation plan.

(c) Evaluate and prepare recommendations for preservation and utilization of scenic, natural, and other water-related recreation resources consistent with other land and water uses.

(d) Prepare estimates of cost and evaluations of benefits for recreation development at project sites.

(3) National Park Service is to:

(a) Determine effect, if any, of projects proposed under the watershed study on archeological, historical, natural, and scientific resources in the watershed.

(b) Evaluate historical and archeological resources in the watershed to determine sites of national significance and those qualified for registry as National Historic Landmarks, if any.

(c) Evaluate natural and scientific resources in the Watershed and identify sites of national significance and national geologic, ecologic, and scenic landmarks, if any.

(d) Participate in joint field reconnaissance of important reservoir sites which may be significant enough to warrant National Recreation Area status.

(4) Fish and Wildlife Service is to:

(a) Inventory existing resources and future needs for water-related fishing and hunting.

(b) Evaluate the fishing and hunting potential of designated water control sites, both existing and proposed, assuming management for resource conservation.

(c) Prepare analysis of effects of proposed water development projects on the fish and wildlife resource and recommend conservation and mitigation devices.

(d) Prepare summarization of relationship of fish and wildlife resource to comprehensive water resource development plan, and prepare evaluation of benefits and costs associated with the fish and wildlife proposals.

(5) Geological Survey is to:

(a) Describe general geo-hydrology of the watershed including areas of potential ground water availability within the basin and those most favorable for development.

(b) Provide advice as to the effect of plans of development on groundwater reservoirs.

G. U. S. DEPARTMENT OF TRANSPORTATION

(1) Bureau of Public Roads. Provide consultation and information as to current and future plans for improvement, modification, relocation or re-construction of roads traversing or bounding the Watershed. Also consult as to the effect of proposed Watershed projects on existing or planned highways.

(2) Bureau of High Speed Transportation. Provide consultation and information as to current and future plans for major change or improvement of railroad passenger transportation in or close to the Charles River Watershed.

H. COMMONWEALTH OF MASSACHUSETTS: METROPOLITAN DISTRICT COMMISSION

(1) The Commissioner was the originator of the request for the 1965 authorized Corps study of the Charles River Watershed.

(2) The Metropolitan District Commission owns or controls nearly all of both banks of the Charles River between the Charles River Dam at Leverett Circle, Boston, and the Watertown Dam above Galen Street, Watertown. In addition, the Commission owns or controls the major portions of both banks of the Charles River between Watertown Dam and South Natick Dam. In total, the MDC today owns or controls 39.1 miles, 80½ percent, of the 48.6 miles (both banks) of the banks of the Charles River between the Boston Dam and Route 109 Dedham-Boston.

(3) By Ch. 768 of the Acts of 1955, Massachusetts General Court, as amended, the Commission is authorized and directed to dredge and otherwise improve the Charles River and its tributaries, including Mother Brook and Long Ditch, so-called, between and including the Watertown Dam and the South Natick Dam so as to relieve flood conditions, and to construct, reconstruct and repair such dams and gates as may be required for such purposes. The Act further provides that the Commission may promulgate rules and regulations for the said purposes and the storage and discharge of water in said streams.

(4) Accordingly, with respect to MDC geographic areas of responsibility, the MDC will consult with the Corps and others on topics, including:

(a) MDC water supply services to Charles River Watershed municipalities, and to selected municipalities adjoining or bordering the Watershed;

(b) MDC trunk sewerage services to Charles River Watershed municipalities and to selected municipalities adjoining or bordering the Watershed;

(c) MDC parklands, recreation facilities and recreation program services in or for use by Charles River Watershed municipalities, and by selected municipalities adjoining or bordering the Watershed which are within the Metropolitan Parks District;

(d) Desires of local interests for modification or physical improvement or other changes in the banks of the Charles River or its tributaries, and in related lands, dams, locks, sluices, fishways, etc.;

(e) Effectuation of MDC assignments in any overall program for water-resource and water-related land area public acquisitions and public developments, resulting either from Corps studies or from prior studies or documented suggestions by others;

(f) Measures for water flow control and for water-quality improvement in the Charles River and major tributaries, including both physical items and legal rules and regulations, in consultation with others.

1. COMMONWEALTH OF MASSACHUSETTS: DEPARTMENT OF NATURAL RESOURCES

(1) Drawing specially on the divisions of Water Resources, Water Pollution Control, Fisheries and Game, Conservation Services, and Forests and Parks, the Massachusetts Department of Natural Resources will consult with the Corps and others on topics including:

(a) Measures for water flow control and for water quality improvement in the Charles River and major tributaries;

(b) Improvement of Water Supply and of Sewage Treatment, in Charles River Watershed municipalities, particularly upstream of South Natick Dam, also increased Pollution Abatement throughout the Watershed;

(c) Availability for recreation or for water supply of former MDC reservoirs and related streams and lands in Hopkinton, Ashland and environs, administered by Massachusetts Department of Natural Resources, bordering the Charles River Watershed;

(d) Availability for use by Charles River Watershed residents of other State Forests or Parks, recreation facilities and recreation program services in or near the Watershed.

(e) Allocation by State of Federal B.O. R. funds and effectuation of the State parts in any overall Watershed program of public acquisition and public development of water-related lands or other lands for forest, park, water-supply, water-flow control or recreation purposes, resulting either from Corps studies or from prior studies or documented suggestions by others.

9. STUDY POLICIES

a. Maximum utilization will be made of existing data such as the report of the New England-New York Inter-Agency Committee (NENYIAC) and reports of Federal, state, municipal and private agencies. Development of new data will be minimized. Examination of alternative measures will be accomplished to the maximum extent practicable by use of past studies and available records. Personnel of participating agencies and the aforementioned Citizen Advisory Committee will be consulted.

b. The investigation will (1) identify the general nature and scope of water resource development needs which will be encountered in future years, confining planning studies to the minimum detail and scope necessary to identify these needs and (2) identify and recommend development of specific projects in which there could be Federal participation under existing legislation, and projects for state and local action.

c. The formulation of plans and evaluation of improvements will conform to policies, standards, and procedures set forth in Senate Document No. 97, 87th Congress, 2nd Session, entitled: "Policies, Standards, and Procedures in the Formulation, Evaluation and Review of Plans for Use and Development of Water and Related Land Resources" and amendments approved jointly by the Secretaries of Agriculture; Army; Interior; Health, Education and Welfare; Commerce; and Housing and Urban Development.

d. The report will recommend authorization for Federal construction of, or participation in, projects required to meet water resource needs by 1980.

e. The report will present an allocation, on a functional basis, of the costs of recommended projects together with appropriate recommendations for Federal and non-Federal cost sharing.

f. The report will suggest ways and means to implement the comprehensive plan recommended for initial development and to phase the construction of the elements of the plan: Federal, state and local.

g. Projects in which there are primary or substantial Federal interests and which are urgently needed may be covered by interim reports. The essentials of such interim reports will be part of the final report. It is proposed to submit an interim report early in the survey covering the critical flood problems of the Charles River Basin in Boston, Brookline and Cambridge, and other Charles River Basin major problems.

h. To the extent necessary for plan implementation, the report will present basic principles which should be covered in water resource laws.

i. Public hearings and other means of communication will be arranged as required to exchange information on water resource needs, problems and suggested improvements.

j. Progress reports are being prepared by the New England Division, Corps of Engineers, in accordance with existing regulations. In addition, periodic reports of status will be made to the Coordinating Committee and interested public and private groups to apprise them of the status of the investigations.

10. ELEMENTS OF INVESTIGATION

In simplest terms, there are four elements to investigations leading to a plan of water and related land resource development for a watershed. These elements are (a) the supply of resources, (b) the demand for them, (c) the net demand or needs, and (d) a reconciliation of supply and net demand or needs. In practice, these elements are not investigated one after the other, but rather are investigated simultaneously to the extent possible. The overlapping time relation is displayed on the Sequence Diagram.

(a) Supply of Resources

Because the end purpose of the comprehensive study is to provide a plan for effective water resource development and conservation, there are three aspects of resource supply which must be evaluated. First are the resources themselves, in this case surface and ground water and closely related land resources. Second are the existing developments and programs. Lastly are the potentials for further development or beneficial program implementation. The resources and resources developments and capabilities are being inventoried by various participants. Tentative identification of potentials for water storage and other resources development are being carried on at the same time.

(b) Demand for Resources

The demands for resources are not limited to the classical demand of the economist but rather combine this with wants and desires which may be met as objectives of society. Gross demand is measured in such terms as people times per capita requirement such as gallons per day of water per capita (weighting factors) or tons of product times gallons per ton of product required. Projections of gross demand are made using numbers from "Projective Economic Studies of New England" and weighting factors appropriate to anticipated future conditions as developed by separate analysis. The projective studies made in 1964-65 under contract with the Corps of Engineers and related efforts provide a common framework for use by all participants in expressing demand. NAR economic data are also available.

(c) Net Demands or Needs for Development

Needs are viewed as those presently unsatisfied demands or those projected to remain unsatisfied in the future without further development or improvement. They are the net of (1) present and future demands generated inside the basin or in outside areas dependent on its resources, and (2) satisfaction by existing developments and programs. Existing resource problems such as flood loss vulnerability and water quality deterioration, and the extension and expansion of these in the future are recognized in the manner of needs. Needs are either expressed in the same terms or where appropriate in terms of the measures required to satisfy them, as for example, acre-feet of storage or miles of channel improvement. Needs topics being considered follow:

(1) Municipal and Industrial Water Supply. Present and future municipal and industrial water quantity and quality requirements to be satisfied from surface and ground water sources are to be estimated. Industrial demands are to include those to be met by municipal systems and those to be met

by other means. The quantity and quality of water being returned to streams are to be estimated as a basis for judging receiving stream quality and dilution water requirements.

(2) Agricultural Water Supply. Present and future patterns and intensities of irrigation water application are to be estimated as well as the changing requirements for rural domestic water, stock water, and other agricultural water.

(3) Environmental Improvement. Flow augmentation storage although inherent in resources considerations such as Water Quality, Recreation, Power, Navigation, would be considered separately as a project purpose. The benefits would be derived from the traditional purposes served, as well as from enhancement.

(4) Navigation. Needs for additional commercial and recreational navigation facilities or for flow augmentation to improve navigation within the basin are to be considered.

(5) Recreation. Recreation needs which could be met by water resources development will be determined and analyzed as a purpose in water resources projects considered for inclusion in the recommended plan of development.

(6) Fish and Wildlife. The fishing and water-related hunting pressures shall be determined as a part of overall outdoor-recreation need and the resource development and management measures to absorb these needs on a continuing basis identified.

(7) Water Quality. Present and future requirements, based on acceptable standards for improving and protecting water quality are to be estimated. Streamflow augmentation is to be studied as a means of improving water quality, and as a supplement to adequate treatment of wastes at their source.

(8) Flood Control Requirements. Flood damage data are to be reviewed and modified as necessary to provide bases for identifying damage center and for project formulation and evaluation.

(9) Major Drainage. Future requirements for drainage of lands are to be developed with particular attention to drainage problems requiring establishment of major drainage outlets.

(d) Methods of Meeting Needs (Reconciliation)

Given the needs and general potentials for meeting them, it is then the goal of planning to select the types and scales of development of these potentials which can best meet the indicated needs. A number of alternative approaches involving single purpose, and, to a larger extent, multiple-purpose solutions are to be explored. From these analyses the more efficient features emerge. These features would be studied in detail using cost-benefit and engineering analyses as the Federal interest in them becomes evident. Basic plan features would be scaled to meet needs projected to develop by 1980. However, where warranted, project scale would be increased to provide satisfaction of needs estimated to develop after 1980.

11. INTERIM REPORT

a. An interim report discussing pollution and flood and other problems in Cambridge, Boston and Brookline, adjacent to the "Charles River Basin", will be submitted.

A review of available reports by local interests and preliminary studies by the Corps of Engineers will be supplemented by further field investigation and studies.

b. OUTLINE FOR INTERIM REPORT AND APPENDICES

The following are the suggested contents of the Lower Charles Interim Report.

LOWER CHARLES INTERIM REPORT OUTLINE

SYLLABUS

CONTENTS

AUTHORITY

SCOPE

Scope of Report

Scope of Studies

PRIOR REPORTS

Federal

Local

GENERAL PHYSICAL DESCRIPTION

Location and Extent

Geology and Soils

Topography

Streams

Climatology

GENERAL ECONOMIC CHARACTERISTICS

Population

Urban Development

Open Spaces

Industry

Institutions

GENERAL ECONOMIC CHARACTERISTICS (cont'd)

Commerce

Education

Transportation and Highways

Navigation

Recreation

Pollution and Sewerage

STREAM FLOW AND RUN-OFF

TIDE DATA

FLOODS

Historic Floods

Floods of Record

Extent and Character of Flooded Area

Flood Damages, General, Annual Losses

PROBLEMS AND NEEDS

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Low Flows

Flood Control

Water Quality

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Maximization of Net Benefits

ALTERNATIVE PLANS CONSIDERED

COORDINATED PLAN

CONCLUSIONS

RECOMMENDATIONS

LOWER CHARLES INTERIM REPORT APPENDICES

OUTLINE

DIGEST OF PUBLIC HEARINGS

HISTORY AND PRIOR REPORTS

GEOLOGY

HYDROLOGY AND HYDRAULICS

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- Runoff
- Streamflow
- Tide Data

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- Urban Renewal Actions Scheduled
- Expressways and Transportation
- Drainage and Sewerage
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- Commercial

DESCRIPTIONS AND COSTS OF CONSIDERED AND RECOMMENDED
IMPROVEMENTS

BENEFITS FROM RECOMMENDED IMPROVEMENTS

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12. ENTIRE CHARLES COMPREHENSIVE REPORT OUTLINE

SYLLABUS

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Recommendations for Federal, State and Local Actions

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Extremes - Storms and Droughts

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Runoffs

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For 1980

For 2020

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B. ECONOMIC STUDIES

C. HYDROLOGY AND HYDRAULICS

D. WATER SUPPLY

E. WATER QUALITY

F. FLOOD CONTROL

G. FISH AND WILDLIFE

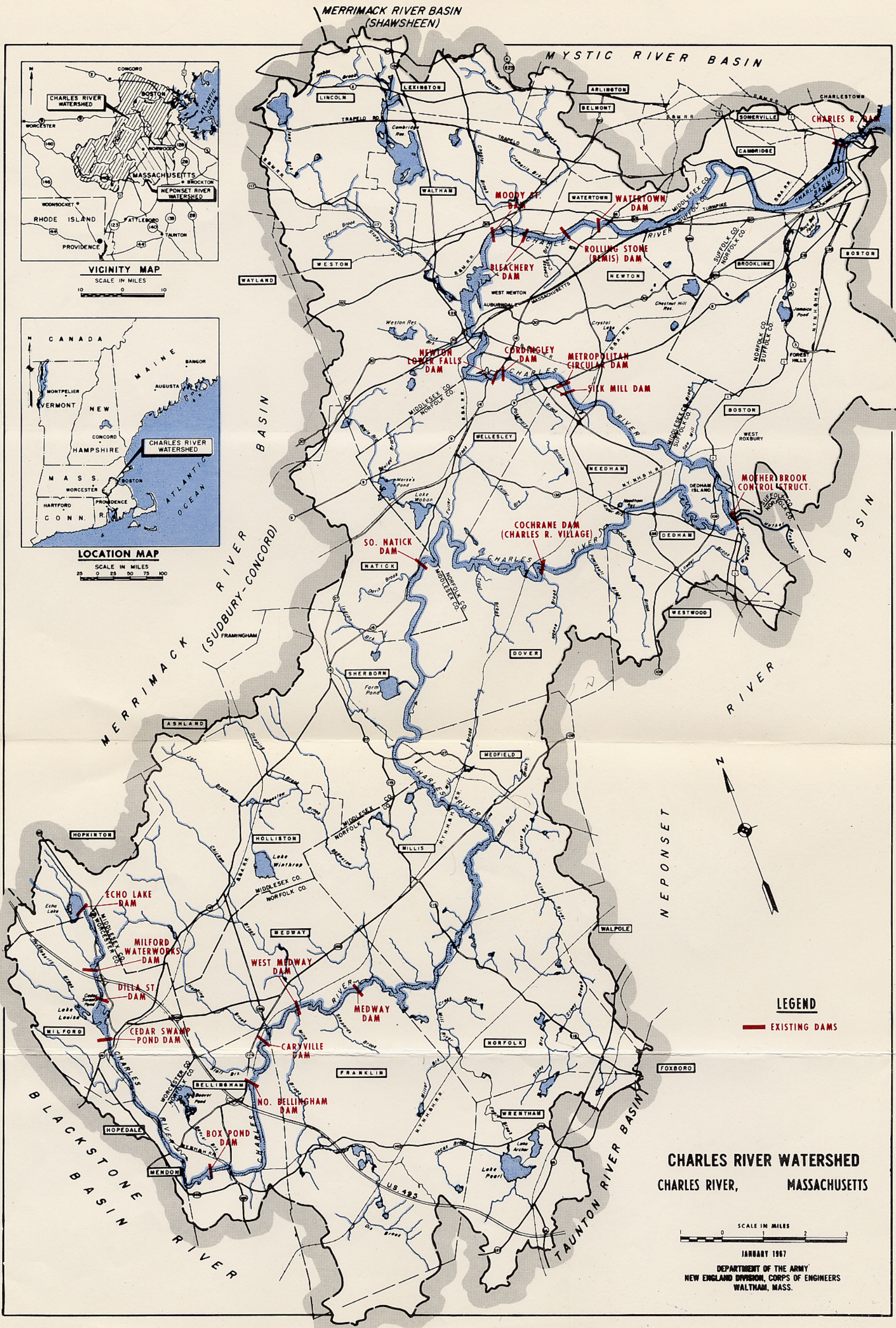
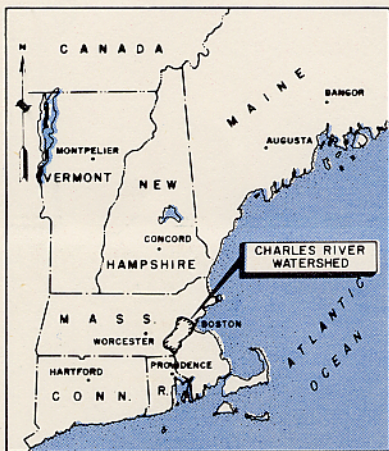
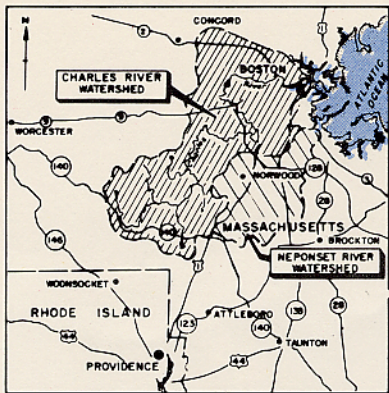
H. OPEN SPACE AND RECREATION

I. NAVIGATION

J. ARCHAEOLOGIC AND HISTORIC SITES

K. WATER AND RELATED LAND RESOURCE PROBLEMS OF THE WATERSHED

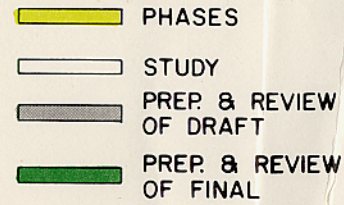
L. EXHIBITS



CHARLES RIVER WATERSHED-COMPREHENSIVE STUDY

SEQUENCE DIAGRAM

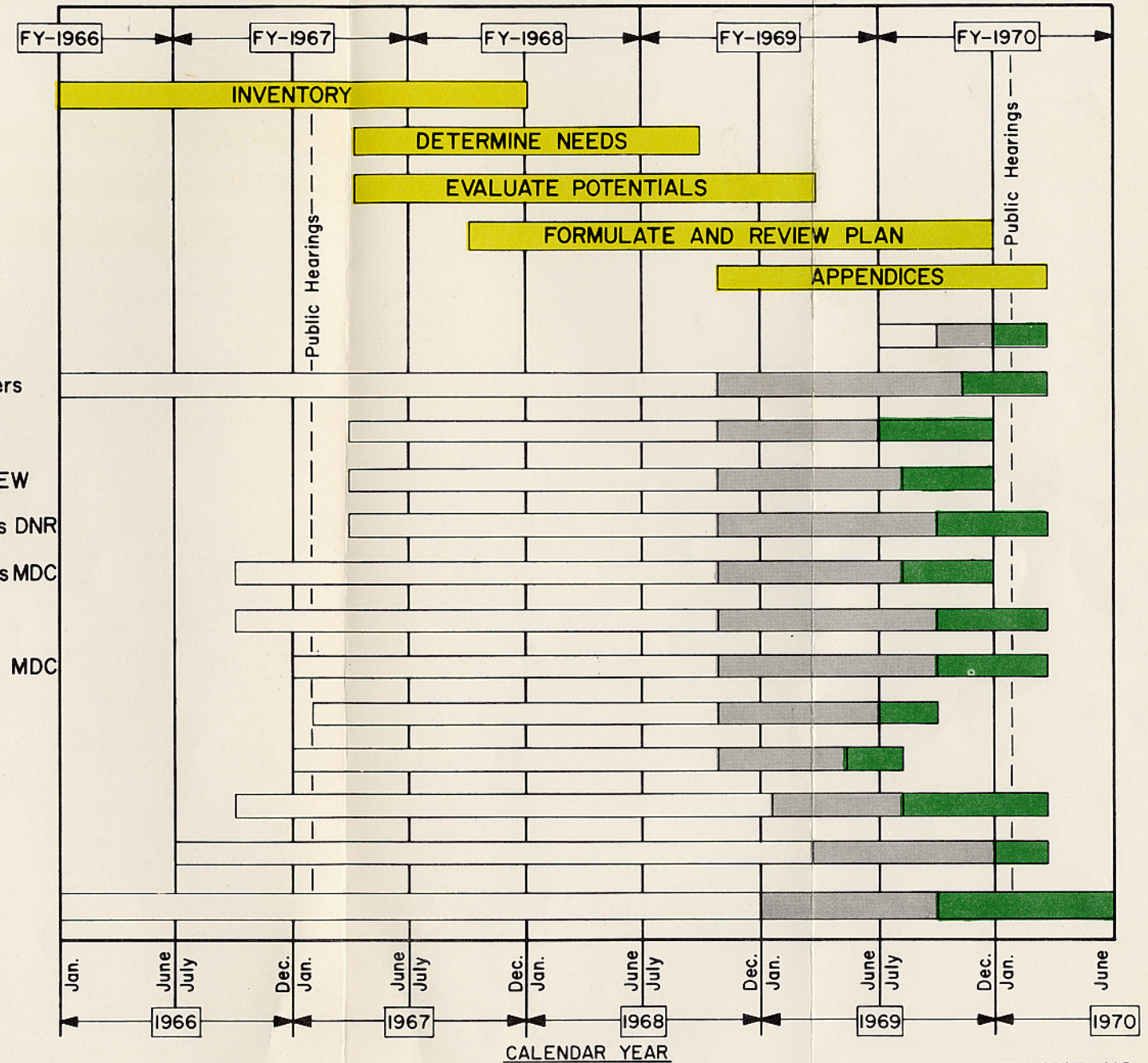
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APPENDICES

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E. WATER QUALITY	USDI, USHEW, Mass DNR
F. FLOOD CONTROL	C of E, USDA, Mass MDC
G. FISH & WILDLIFE	USDI, Mass DNR
H. OPEN SPACE & RECREATION	USDI, USHUD, Mass MDC
I. NAVIGATION	C of E, Mass MDC
J. ARCHAEOLOGIC & HISTORIC SITES	USDI, others
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L. EXHIBITS	C of E, others

MAIN REPORT



CHARLES RIVER WATERSHED STUDY

MEMBERS OF COORDINATING COMMITTEE AND PARTICIPANTS IN COMPREHENSIVE WATER AND RELATED LAND RESOURCE INVESTIGATIONS

FEDERAL					
DEPT. OF ARMY	DEPT. OF AGRICULTURE	DEPT. OF INTERIOR	DEPT. OF COMMERCE	DEPT. OF HEALTH, EDUCATION & WELFARE	DEPT. OF HOUSING AND URBAN DEVEL.
CORPS OF ENGINEERS 'CHAIR AGENCY'	ECONOMIC RESEARCH SERVICE SOIL CONSERVATION SERVICE FOREST SERVICE	BUREAU OF MINES BUREAU OF OUTDOOR RECREATION FEDERAL WATER POLLUTION CONTROL ADMINISTRATION FISH AND WILDLIFE SERVICE GEOLOGICAL SURVEY OFFICE OF WATER AND POWER NATIONAL PARK SERVICE	ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION 'WEATHER BUREAU' AND CONSULTATION WITH. BUREAU OF THE CENSUS BUREAU OF PUBLIC ROADS ECONOMIC DEVELOPMENT ADMINISTRATION	PUBLIC HEALTH SERVICE	COMMUNITY FACILITIES ADMINISTRATION URBAN RENEWAL ADMINISTRATION HOUSING & HOME FINANCE AGENCY PUBLIC HOUSING ADMINISTRATION FEDERAL HOUSING ADMINISTRATION FEDERAL NATIONAL MORTGAGE ASSOC.
STATE					
COMMONWEALTH OF MASSACHUSETTS					
DEPARTMENT OF NATURAL RESOURCES METROPOLITAN DISTRICT COMMISSION					

**CHARLES RIVER WATERSHED STUDY
CITIZEN ADVISORY COMMITTEE**

Mrs. Talbot BAKER	LWV, Chas. R. Group	Millis
Chas. W. BARTLETT	Broad Public Interest	Dedham
Thos. D. CABOT	" " "	Weston
Miss Roberta CHESNUT	Fenway	Back Bay
Frank S. CHRISTIAN	Boston Ch. Commerce	Boston
Wm. H. CLAFLIN	Broad Public Interest	Belmont
Henry J. COLOMBO	Mass. Wildlife Fed'n.	Wilmington
Mrs. F. Murray FORBES	League of Women Voters	Boston
Mr. John J. GILL	Town Planning Boards	Needham
Mrs. H. Shippen GOODHUE	LWV, Chas. R. Group	Wellesley
Mrs. Russell HADDLETON	LWV, Chas. R. Group	Dover
Mr. Richard C. HILL	Midd'x. Soil Cons. Dist.	Bellingham
Howard McINTYRE, Jr. M. D.	Up-River Regatta	Cambridge
Mr. James A. MILLER	Newton City Planner	Auburndale
Mrs. Thos. P. MURRAY	LWV, Chas. R. Group	Franklin
Mr. Geo. A. ORROK	Boston Edison Co.	Cambridge
Mr. John F. PLIMPTON	Mass. Forest & Park Assn.	Sherborn
Mr. Thos. PRENTISS	Manufacturing in flood plains	Cambridge
Mr. Henri PRUNARET	Town Planning Boards	Natick
Mr. Nathan M PUSEY	Universities & Colleges	Cambridge
Hon. Leverett SALTONSTALL	Broad Public Interest	Dover
Mr. Benj. F. SHATTUCK	Newton Conservators	Newton
Mr. Geo. C. SHATTUCK, M. D.	Nature Conservancy	Brookline
Mr. Robert T. SYMONDS	Supt. Milford Water Co.	Milford
Mr. Daniel G. WHEELER	Realtors-Developers	Dover
Mr. Walter M. WHITEHILL	Historic-Preservation	No. Andover
Mr. Kenneth H. WOOD	Chas. R. Watershed Assn.	Norfolk
Mr. Arthur WILLIAMS	Governor's Legis. Counsel	
Mr. Edw. S. MORROW	Governor's Asst. Legis. Counsel	